



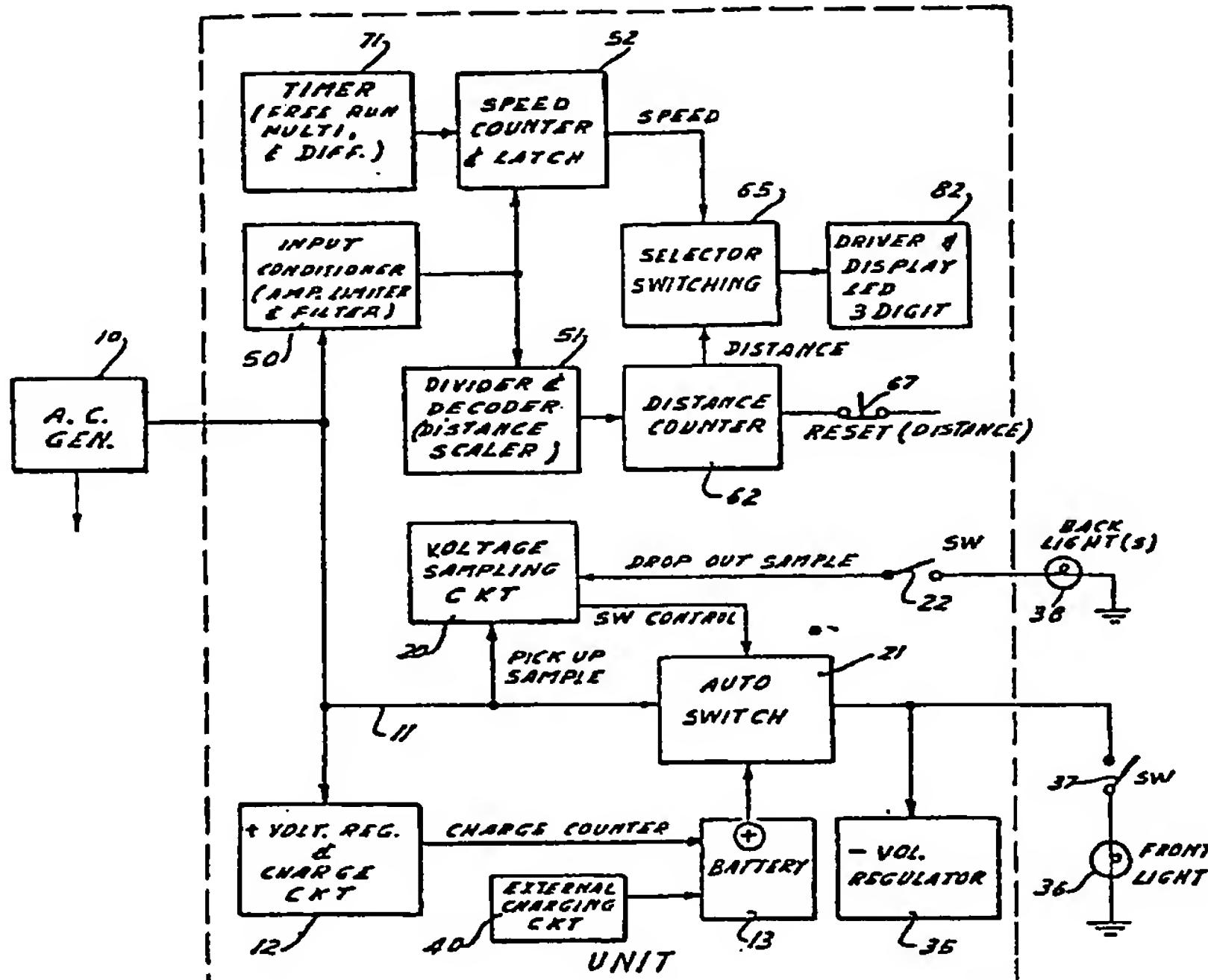
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(54) Title: BICYCLE OR OTHER VEHICLE GENERATOR IMPROVEMENT UNIT

(57) Abstract

A generator (10) is provided powered by the rotating wheel of a bicycle, for producing power for lamps (36, 38) for the bicycle. The cycles of the voltage, which are related to distance travel, are converted to digital form for use in counting and timing circuit to display speed and traveled distance. A rechargeable battery (13) is also provided for the lighting circuit, with an automatic changeover switch (21) for charging the battery and energizing the lamps (36, 38) when the generator voltage is sufficiently high.



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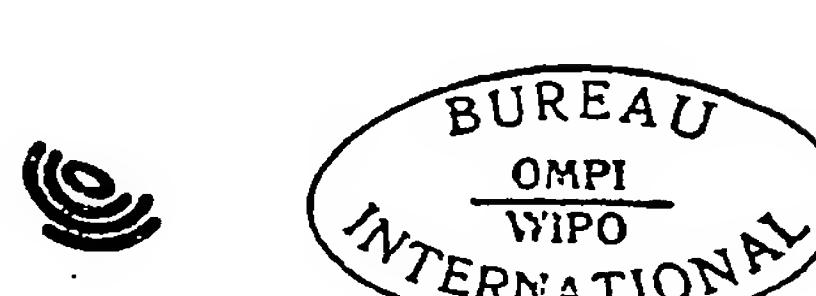
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BICYCLE OR OTHER VEHICLE GENERATOR
IMPROVEMENT UNIT

Background of the Invention

This invention relates to accessories for vehicles, especially bicycles, and is particularly directed to a combination of a generator and lamp circuit for a bicycle, with the additional features of a rechargeable battery, a charging circuit for the battery, and a speedometer and odometer.

In the past, it has been conventional to provide generators for bicycles, for operating one or more lamps on the bicycle. Such systems are disclosed, for example, in U. S. Patent No. 4,069,451, Rouse; U. S. PATENT No. 3,753,000, Newman; U. S. Patent No. 3,792,307, Baker; U. S. Patent No. 3,894,281, Bloomfield and U. S. Patent No. 2,299,762. In the systems of these references, generators are provided which may be rotated by shaft elements engaging the rim of the wheel. The circuits disclose various features, such as the use of AC generators, the use of DC generators, rectification of the output of the generator, and the provision of batteries which may be employed to separately energize the lamps. Further, the Rouse patent discloses the provision of filtering and limiting devices for the generator, and the Newman reference discloses the use of a rectifier in combination with a DC generator for charging the battery when the lamps are not connected. Rectifier circuits of this type are generally employed in series with the load, in view of the belief that the use thereof is superior to the provision of mechanical switches.



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In accordance with the present invention, however, it is desired to provide as efficient a system as possible, as well as as economical a system as possible, for the fabrication and use of lighting circuit of a bicycle. For this purpose, therefore, it has been found that electro-mechanical switches are in fact superior to electrical rectifiers, in view of the significantly reduced voltage drop thereacross in use, and the reliability of present day mechanical switching contacts. Therefore, in accordance with the invention, the voltage applied to the lamps of a bicycle may be significantly higher (or, alternatively, the output of the generator may be employed to supply the lamps at a lower voltage) than in the past, where semiconductor diodes have been employed. In addition, by employing AC power to the lamps, a still greater increase in efficiency is provided. Diodes are used in accordance with the invention, only for the charging of the battery and voltage detection, and are not employed in the rectification of power currents, so that the efficiency of the system is maintained at the highest possible levels.

It has also been known in the past to provide speedometers and/odometers for use in bicycles, such devices being powered by means of an electric generator. Such systems are disclosed, for example, in U. S. Patent No. 4,156,190, Chittenden; U. S. Patent No. 3,784,913, Maass; U. S. Patent No. 3,898,563, Erisman and U. S. Patent No. 4,007,419. In each of these references, the signal applied to the speedometer or odometer is related to the angular displacement of the wheel of the bicycle, whereby the device is useful only for bicycles of a given wheel size, i.e., major modifications are necessary for use of the device on bicycles of different wheel sizes.



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Summary of the Invention

The present invention is therefore directed to the provision of a combined generator, rechargeable battery, charging circuit, speedometer and odometer for a vehicle, especially a bicycle, that does not have the above disadvantages. While the system of the invention may be provided for a complete unit, it will be apparent that it is sufficiently versatile that the required speedometer and odometer capabilities may be readily and easily adapted to bicycles that already incorporate generators and lamps or other output devices, and that rechargeable battery systems may also be incorporated into such existing systems with a minimum of cost and effort.

Briefly stated, in accordance with the invention, it is necessary to provide an AC or pulse generator, preferably an AC generator, for the bicycle, and the generator be mounted such that the cycles correspond to increments of distance along the tire or rim of the bicycle. Such arrangements are conventionally provided, for example, by engaging a rider with the side of the wheel of the bicycle, for turning the rotor of the generator.

In accordance with the invention, a rechargeable battery is provided for lighting the lamps or other load of the bicycle when the generator output voltage is inadequate, the lamps or load being energized by way of mechanical contact. When the output voltage of the generator is sufficiently high, in dependence upon the selected load, a detection circuit effects the closure of mechanical contacts so that the generator output voltage energizes the load, and maintains the contacts in a hold position until such time as the speed of the bicycle reduces to a determinate level. The rechargeable battery is also charged by the AC generator, when the output



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voltage therof is sufficiently high, although the recharging current may proceed by way of semiconductor diodes. Currents in this case may be adequately low that the efficiency of the system is not greatly impaired.

In addition, the wave form of the AC voltage may be shaped and amplitude and limited to provide pulses for operating a speedometer and odometer circuit, the rectified output of the battery, for the recharging function, being employed for the operating voltage for the speedometer and odometer circuits.

The system of the invention thereby does not entail the use of complicated circuit configurations, is adapted to the use of conventional integrated circuits, and may be readily incorporated into existing systems.

Thus, in an existing system having an alternating current generator and lamps, it is merely necessary to change the connections of two wires of the existing system to install a recharging circuit, odometer and speedometer fabricated in accordance with the invention. The efficiency of the system, avoiding the use of rectifiers for the lamp load, thereby reduces the energy required on the part of the bicycle rider, and enables brighter light and/or light at lower speeds, than is existing systems which employ semiconductor devices in series with the lamp load on the bicycle circuit.

Brief Description of the Drawings

In order that the invention will be more clearly understood, it will now be disclosed in greater detail with reference to the accompanying drawings, wherein:

Fig. 1 is a block diagram of an electrical system for a bicycle, in accordance with the invention.



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including a generator, one or more lamp loads, a rechargeable battery and charging circuits for the battery, and a speedometer/odometer and display system;

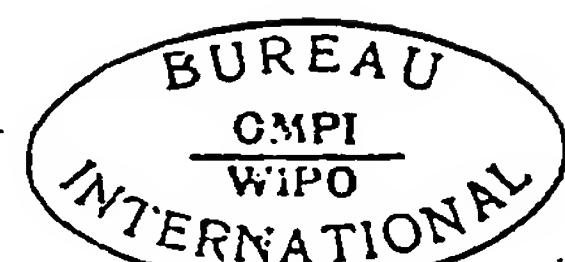
Fig. 2 is a circuit diagram of the portion of the circuit of Fig. 1 including the generator and lamp loads, as well as the battery, recharging circuit, and automatic switching systems for the generator;

Fig. 3 is a detailed circuit diagram of an embodiment of the portions of the circuit of Fig. 1 including the odometer circuit, speedometer circuit and the display circuits; and

Fig. 4 is a circuit diagram of a modification of the circuit of Fig. 3, wherein a substantially non-volatile source of power is provided for the odometer circuit, whereby the parameter of distance traveled may be stored at times when the normal battery is not functioning.

Detailed Disclosure of the Invention

The system in accordance with the invention is comprised essentially of two sub-systems. The first of these, which incorporates devices which may already have been provided on the bicycle, includes an AC generator, a rechargeable battery, one or more lamps or other devices that will be energized by either the battery or the generator, and a charging and control circuit. The second major portion of the system includes those circuits which are concerned with the display of speed of the bicycle, and/or the distance that the bicycle has traveled. The first of these sub-systems will initially be disclosed, in accordance with a preferred embodiment of the invention, with reference to Figs. 1 and 2.



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Power Generation, Control and Lighting

As illustrated in Figs. 1 and 2, the system in accordance with the invention is comprised of an AC generator 10. This generator may be of a type that is conventionally employed on bicycles, having, for example, a shaft fitted with a friction element or the like for engaging the side of a tire of the bicycle in order to effect the rotation of the rotor of the generator. These features are of importance to the present invention, as will be apparent from the following paragraphs, since, within a reasonably high degree of accuracy, a cycle of the alternating output of the generator will correspond to a determinable distance of travel of the bicycle. Further, although the system may thereafter be designed on the basis of a bicycle having a given wheel diameter, the accuracy of the system will not be seriously impaired even though the system is employed without modification on bicycles having any conventional wheel diameter. It is therefore stressed again that the generator 10 is an AC generator. One of the terminals of the generator is connected to a point of reference potential, referenced herinafter as the ground of the system. The other terminal thereof is connected by the output line 11 to a voltage regulator and charging circuit 12. A rechargeable battery 13, such as a nickel-cadmium battery, has its negative terminal grounded and its positive terminal connected to a lead 14, which serves as the battery output of this portion of the system, and is connected to the cathode of a diode 15 within the voltage regulator circuit. The anode of a further diode 16 is connected to the generator line 11, the cathode of this diode being connected by way of a resistor 17 to the anode of the diode 15. The cathode

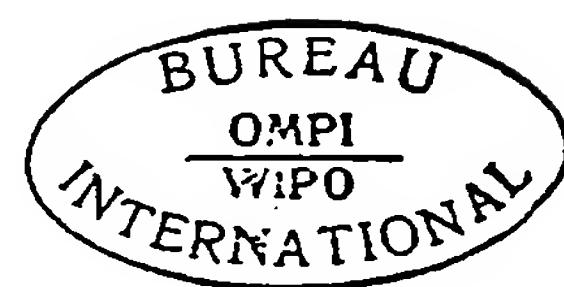


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of the diode or rectifier 16 is connected to a Zener diode 18, and thence to reference ground. In this circuit, it is apparent that the diode 15 prevents discharge of the battery by way of the generator, and the combination of the diode 16 and Zener diode inhibit charging current from being applied to the battery until the positive peaks of the generator output are slightly above the battery voltage. The resistor 17 serves as a current limiting resistor. While this element is illustrated as being a passive element, it is apparent that the efficiency of the system would be improved by the use of a dynamic device.

The output of the generator, on line 11, is also applied to a voltage sampling circuit 20, an automatic switch 21, and to one fixed contact of a single-pull double-throw switch 22. The voltage sensing circuit includes a relay having a coil 25, the normally closed and normally open contacts 26 and 27 therof constituting the automatic switch 21. The two contacts of the relay are serially connected.

One end of the coil 25 is grounded. The generator output line 11 is connected to the cathode of a diode 28 and thence to the other end of the coil of the relay by way of a Zener diode 29. Thus, only negative peaks of the generator output are coupled to the coil of the relay, the Zener voltage of the diode 29 determining thereby the energizing voltage to be applied to the relay to effect operation of the automatic switch. This level may be arbitrarily determined on the basis that the voltage must be adequate at this time to enable the energization of the lamps on the bicycle at a reasonable illumination level. This level may, and preferably is, below the output voltage of the rechargeable batteries. As is conventional, a capacitor may be



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connected in shunt with the winding of the coil 25.

The battery line 14 is connected to the other terminal of the normally closed contact 26, and the generator output line 11 is connected to the other terminal of the normally open contact 27. Further, the centers of these two contacts are connected to the other fixed contacts of the switch 22, the movable contact of the switch being connected to a line 30. With these interconnections it is apparent that, in the position of the switch 22 as illustrated, the battery voltage will be applied to the line 30 when there is insufficient generator output for the lamps, and the generator output line 11 will be interconnected with the line 30 when the voltage thereon is above the threshold level of the voltage sampling circuit. Further, in the non-illustrated position of the switch 22, the battery 13 will always be disconnected from the lamps, and the generator output line 11 will be connected to the lamp line 30 when the voltage output of the generator is adequate.

It will further be noted that the generator output is connected to the line 30 by way of mechanical switch contacts, whereby losses occasioned by semiconductor switches or the like are not present in the system in accordance with the invention.

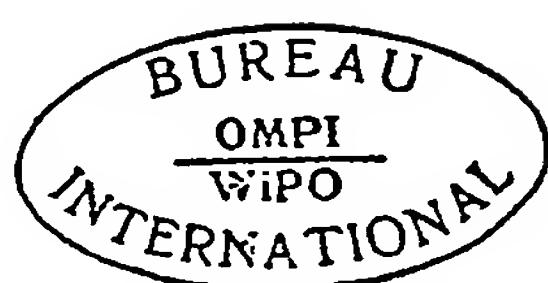
The common line of the contacts 26 and 27 is also connected to the coil 25 of the relay by way of serially connected diodes 33 and 34, in that order, poled to pass current when the voltage at the common contact is negative. It is a consequence, once the relay has been initially energized, this current path will maintain the energization of the relay by the generator. This holding effect is at a lower voltage



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than that required to initially energize the relay. Thus, initially it was necessary to sense a voltage such as required by the light voltage, plus the internal generator voltage drop assuming a load was connected to the circuit. As soon as the lights are lit by the AC generator, there is a voltage drop due to the internal resistance of the AC generator, so that it is now necessary to sense a new voltage with a new set of criteria. In this circuit, the diode 34 could be replaced by a series of diodes, or by a Zener diode (connected in the opposite direction) to change the detection criteria. A negative voltage regulator 35, i.e., a Zener diode, is connected between referenced potential and the junctions of the diodes 33 and 34. This Zener diode clamps the negative half cycle of the AC input to insure that it does not go above the specified limits of the Zener diode. This function protects the relay coil against over voltage and also serves in conjunction with the positive clamping circuit to regulate the voltage supplied to the lights.

The switch 22 may be employed, for example, in the event that the batteries are removed from the circuits, or are discharged. The line 30 is connected to the front lamp 36 of the bicycle by way of a switch 37, as well as to a back light 38 of the bicycle by way of a switch 39. It is preferable to employ separate switches for the lamps, in order to save electricity when it is not necessary, for example, to have the front lamps on. If desired, an external charging circuit 40 of conventional nature may be connected to the battery line 30, for example, employing a tip jack, if it may be desired to charge the batteries from some other source of power, such as from AC house current.



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Speedometer/Odometer Circuit

As illustrated in Figs. 1 and 3, the generator line 11 and the positive output voltage line 30 are also applied to the speedometer/odometer circuit. The positive voltage on line 30 is employed as a positive operating voltage for this circuit, while the generator output voltage on line 11 is employed as a signal voltage since the cycles of this voltage are a measure of the distance traveled by the bicycle. Thus, as discussed above, if the generator is directly driven by the rim of a bicycle wheel, the AC cycles of the generator output will occur at intervals corresponding to the distance traveled by the bicycle, independently of the wheel size of the bicycle.

The line 11 is first applied to an input conditioner (amplifier, limiter and filter) circuit 50. This circuit may employ diodes connected to limit the potential applied to the speedometer to potentials between the ground reference and the positive supply, as well as resistance-capacitance low pass filter elements. A transistor may be employed to amplify the AC voltage, with an output diode clamp also being employed. The output of this circuit is connected to a divider and decoder 51, as well as to a speed counter and latch 52. The line 30 is connected to the speedometer circuit by way of an isolating diode 53, for the supply of the minimum current operating semiconductor devices of the circuit. A display switch 54, however, may be employed for disconnecting the display devices, since these devices, such as light-emitting diodes, may otherwise drain the battery to an undesirable extent. If low current display devices, such as LCDs are employed, however, this switch may be omitted if desired.



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In the circuit diagram of Fig. 3, the device numbers of commercially available integrated circuits are shown, along with the pin numbers of these devices, in order that the circuit of the invention will be more clearly understood. The devices may, for example, be CMOS devices as illustrated, for low current operation. It will, of course, be apparent that other devices may be employed, the circuit of Fig. 3 being organized on the basis of presently available components.

The design of the circuit in accordance with the invention may proceed on the basis that the circuit should indicate the speed of the bicycle at a minimum value, for example, one-tenth of a mile an hour. A signal at this speed, from the generator, has a very low voltage, and this is the reason that the amplifier has been provided in the input condition in the circuit. The filter is required in order to remove noise from the generator output, and the limiter is necessary since the output of the generator, at higher speeds, may exceed the safe operating voltages for the circuits. It will, of course, be apparent that conventional circuitry may be employed for these purposes. The outputs of the input conditioner is applied, as illustrated in Fig. 3, to a buffer in chip 60 (a 4023), the output of this buffer being applied to a 14-stage decoder/divider 61 for division. This divider, in one embodiment of the invention, is connected to provide output divisions at counts of 4096, 512 and 216, and these outputs are connected to three input NAND gate in the IC chip 60, to provide an output with a division of 4864. The pulse output of this NAND is thence applied to a distance counter 62 in the form of a re-settable counter chips 63 (4553). The counter 63 thereby counts a number of pulses applied thereto, which corresponds to 1/4864 of the frequency of the generator. This division



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corresponds to one-tenth of a mile, in accordance with the above example, based upon the size of the generator, the size of the rotary drive for the generator, and the size of the wheel, and the distance traveled. In the given example, this division will provide an accuracy of about 2 1/2%. A further factor in the division would have enabled increased accuracy, for example, up to about 0.2%. The counter 63 is connected to provide counts at the lowest, central and most significant bits, at terminals 15, 1 and 2 respectively, of a three-digit decimal number. These output pulses are applied to a pulse selector switch 65, for example, a quad and/or select gate 66 (Type 4019) at terminals 7, 5 and 3 respectively. (It will be apparent that the circuit illustrated is multiplexed in conventional manner, in order to provide a seven-segment display output).

The above portion of the circuit further includes a reset switch 67 connected to the distance counter 63, for resetting the odometer portion of the circuit to zero or any desired fixed base.

The speedometer portion of the circuit includes a speed counter and latch 52 in the form of a counter 70 (a Type 4553) connected to count the generator output pulses from the input conditioning circuit, that occur within a given period as determined by a timer 71. The timer may comprise a Type 555 timer 72 connected as a free running multivibrator, the output at terminal 3 thereof providing a latch for the counter 70. A differentiating circuit 73 connected to the output of the 555 latch 72 provides a reset pulse on line 74 for the counter 70. The timer circuit, in the above example of the invention, is connected to provide an approximately, 0.7 second pulse every 0.701 seconds. Initially, the latching of the speed counter effects the store and dis-

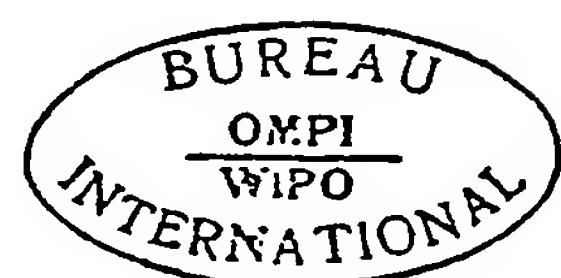


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play of information within the speed counter, i.e., the count of the previous cycle, the differentiator thereby resetting this counter to zero after the data therein has been applied to the output circuit. Thus, when the reset signal drops, the counter 70 is enabled approximately 0.7 seconds to count the number of generator cycles applied thereto. After this 0.7 seconds, the latch voltage drops to enable the transfer of this number of counts to the counter memory, with the consequent reset of the counter upon receipt of the reset volts. The output of the counter 70, in the form of pulses corresponding to the least, central and most significant bits of a three-digit decimal number are applied to the terminals 6, 4 and 2 of the switching device 66.

In the circuit of Fig. 3, for convenience, the switch 64 is shown as having separate portions 65A and 65B, the portion thereof 65A controlling the display of the digit at any instant. This switch has a further section 65B for controlling the BCD counts stored in the counters. The BCD output of the switch 80 is applied, on lines W, X, Y and Z to a BCD to seven-segment converter 84 (Type 4543), while the decimal enable outputs are applied by way of driver transistors to the seven-segment display devices (such as LEDs) 82. The seven-segment output signals from the decoder 84 are also applied to these display devices in the conventional multiplex fashion. The manual switch 81, connected to the switches 66 and 80, enables either the display of the odometer count, or the speedometer count.

It will of course be apparent that many modifications may be made in the system as above disclosed.



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Thus, the resistor in the charging circuit may be replaced by a transistor or integrated circuit enabling the application of a constant charging current to the battery. Further, the timing circuit of the timer of Fig. 3 may be replaced by a linear or non-linear integrated circuit. Further, non-linear circuit decoding may be introduced into the decoder circuit of the odometer in order to improve accuracy, and also to eliminate some of the discrete components.

While the invention has been described with reference to the three-digit display, it is of course apparent that more or less digits may be employed, as desired, and that the division ration may be reduced in order to display, for example, 100ths of a mile or 1000ths of a mile.

Further, as illustrated in Fig. 4, a backup battery 90 may be connected to the divider circuit 51 and distance counter 62 of the odometer, in order to simulate a non-volatile memory, whereby the backup battery will be charged while the generator voltage is sufficiently high, but the storage in the counter circuits will be maintained over long periods of time even though the bicycle is not in use. Further it is alternately, of course, a non-volatile memory may be employed. Further, it is of course apparent that changes in the division ration will enable display of the distance and speed in units of the metric system. If desired, suitable conventional switches may be employed to enable alternate display in the metric system. Multiple displays may of course be provided also, to simultaneously show distance and speed. As a further modification, means may be provided for producing a signal corresponding to a determined speed or distance, for comparison with the outputs of the odometer and speedometer



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counters to produce an audible or visual signal when the speed or distance are above or below determined levels. Alternatively, such outputs can be employed for serving other functions. Further, a solid state Hall Effect switch may be employed for sensing suitable magnets mounted on a rotary member of the bicycle, or electromagnetic or Eddy current sensors may be employed and mounted to sense uneven metal surfaces such as gear teeth or sprockets on the rotary member, for the speedometer-odometer function. It is apparent that the present invention therefore covers each such variation and modification as falls within the true spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A circuit for providing a display of a distance related function for a vehicle, comprising a AC generator for producing a voltage having a wave-form with a cycle that is directly proportional to distance traveled by the vehicle, means producing a direct operating voltage for said circuit from said voltage having said wave-form, and means for counting the number of cycles of said voltage having said wave-form for providing said display.

2. The circuit of claim 1 wherein said function is speed, wherein said means for counting comprises means for periodically counting the number of cycles of said wave form in a determined time period, and means for displaying said count.

3. The circuit of claim 2 comprising means for producing pulses from said wave form for application to



15a

WHAT IS CLAIMED IS:

1. A circuit for providing a display of a distance related function for a vehicle, comprising a AC generator for producing a voltage having a wave-form with a cycle that is directly proportional to distance traveled by the vehicle, means producing a direct operating voltage for said circuit from said voltage having said wave-form, and means for counting the number of cycles of said voltage having said wave-form for providing said display.
2. The circuit of claim 1 wherein said function is speed, wherein said means for counting comprises means for periodically counting the number of cycles of said wave form in a determined time period, and means for displaying said count.
3. The circuit of claim 2 comprising means for producing pulses from said wave form for application to



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said counting means.

4. The circuit of claim 1 wherein said function is distance, and said means for counting the number of cycles of said voltage comprises pulse counting means and means for displaying the count of said counter.

5. The circuit of claim 1 wherein said means for counting comprises a first counter for counting the number of cycles, a second counter for periodically counting the number of said cycles in a determined time period, said second counter being reset at the end of each said periodic time period, and means for selectively displaying the counts of said first and second counters.

6. The circuit of claim 1 further comprising a lamp load, and mechanical contact means for connecting said lamp load to said generator.

7. The circuit of claim 6 comprising means responsive to voltage output of said generator for operating said mechanical contacts.

8. The circuit of claim 1 further comprising a battery, and means for operating said circuit from said battery when said voltage is below a predetermined value.

9. The circuit of claim 8 further comprising recharging circuit means coupled to charge said battery from said generator when the voltage of said generator reaches a predetermined amplitude greater than the battery voltage.



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10. The circuit of claim 1 wherein said generator is an AC generator, said AC generator is of the type driven by a rim or the side of a tire of a bicycle, whereby the display of said function is independent of the diameter of wheel of said bicycle.

11. A bicycle lighting circuit comprising an AC generator having a wave cycle that is a direct function of distance traveled, a load device, a rechargeable battery, a solid state circuit connected to charge said battery by said generator when the voltage of said generator exceeds the battery voltage by a determined amount, and automatic switch means including mechanical contacts for selectively connecting said battery and generator to said load device without the interposition of rectifying means.

12. The circuit of claim 11 further comprising means responsive to the wave cycle of said AC generator for producing a display of a function related to distance.

13. The circuit of claim 11 wherein said automatic switch means comprises a relay having a pair of contacts for selectively connecting said battery and generator to said load device, means energizing said relay at a determined voltage output of said generator, and means holding energization of said relay at a voltage output of said generator lesser than said predetermined voltage.

14. The circuit of claim 13 wherein said means for energizing comprises a series connected diode and Zener diode connected between the diode of said generator and the coil of said relay.



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15. The circuit of claim 14 wherein said load device is a lamp load, and said predetermined voltage is a voltage at which said lamp load is energized to a sufficient extent for night travel, and further comprising limiting means for limiting the amplitude of voltage from said generator that is applied to said lamp load.

16. The lighting circuit of claim 11 wherein said diode circuit is connected to charge said battery at a given polarity of the wave form of said generator, and said automatic switch means is responsive to the amplitude of the opposite polarity of said wave form for controlling said mechanical contacts.

17. The circuit of claim 2 further comprising means for producing a comparison-present speed compared to preset speed.

18. The circuit of claim 1 further comprising a rectifier and capacitor for operating said circuit and display from said rectifier and capacitor.



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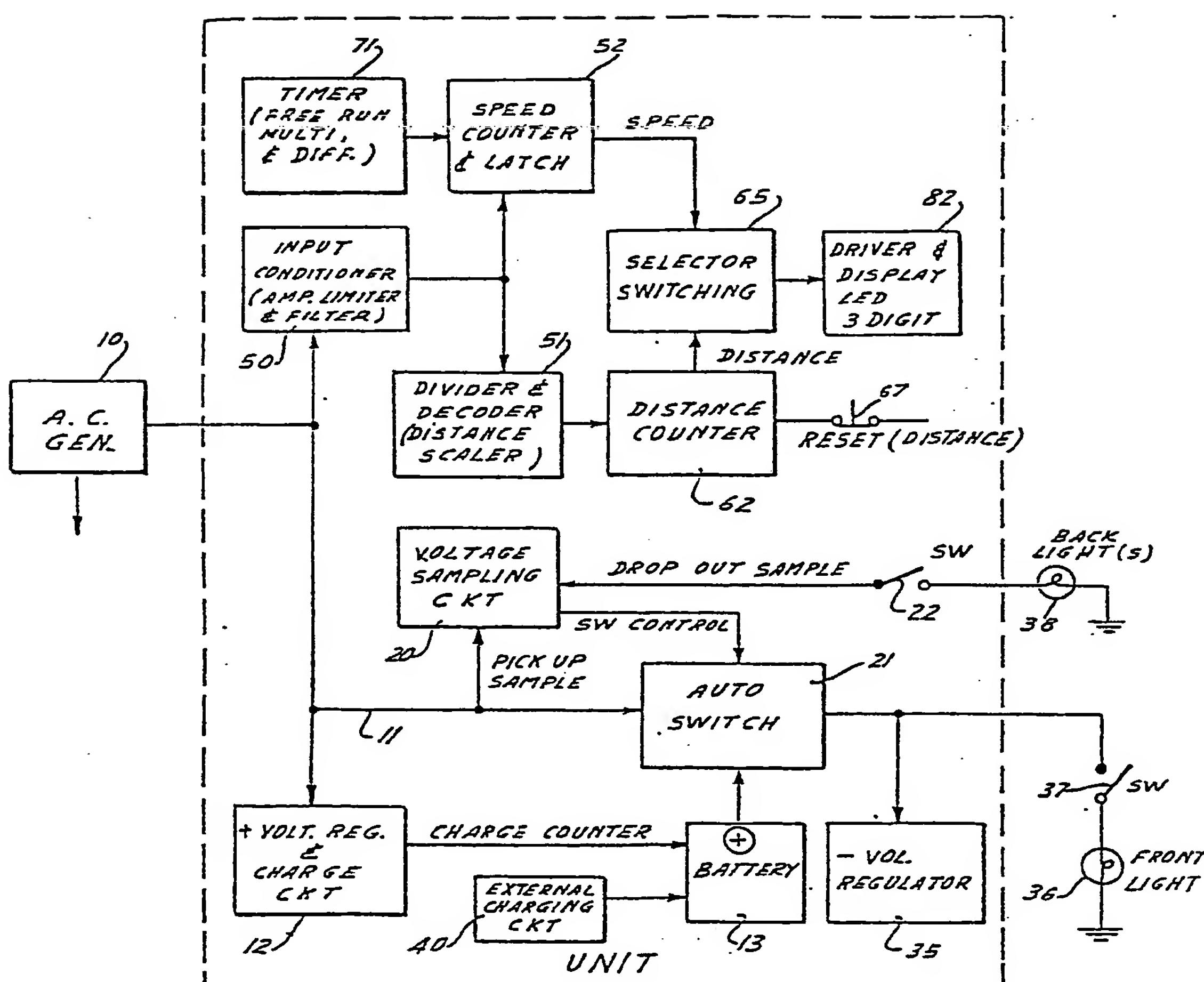


FIG. 1



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FIG. 2

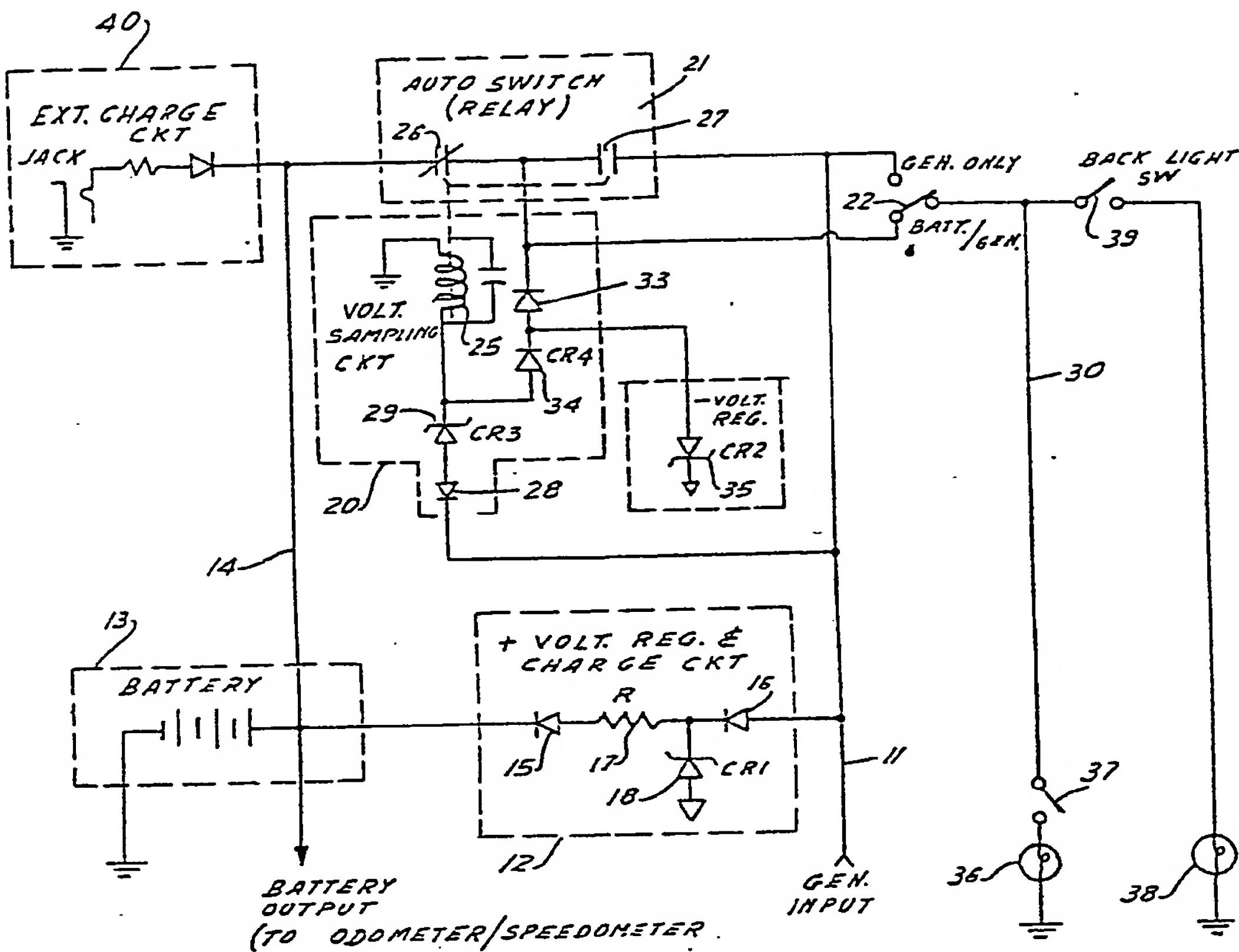
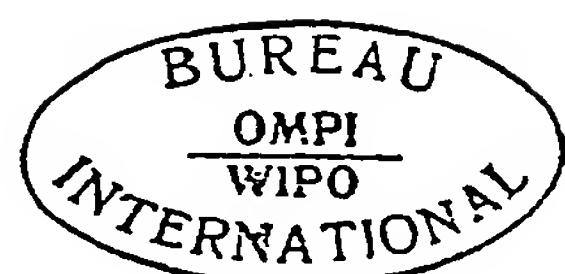
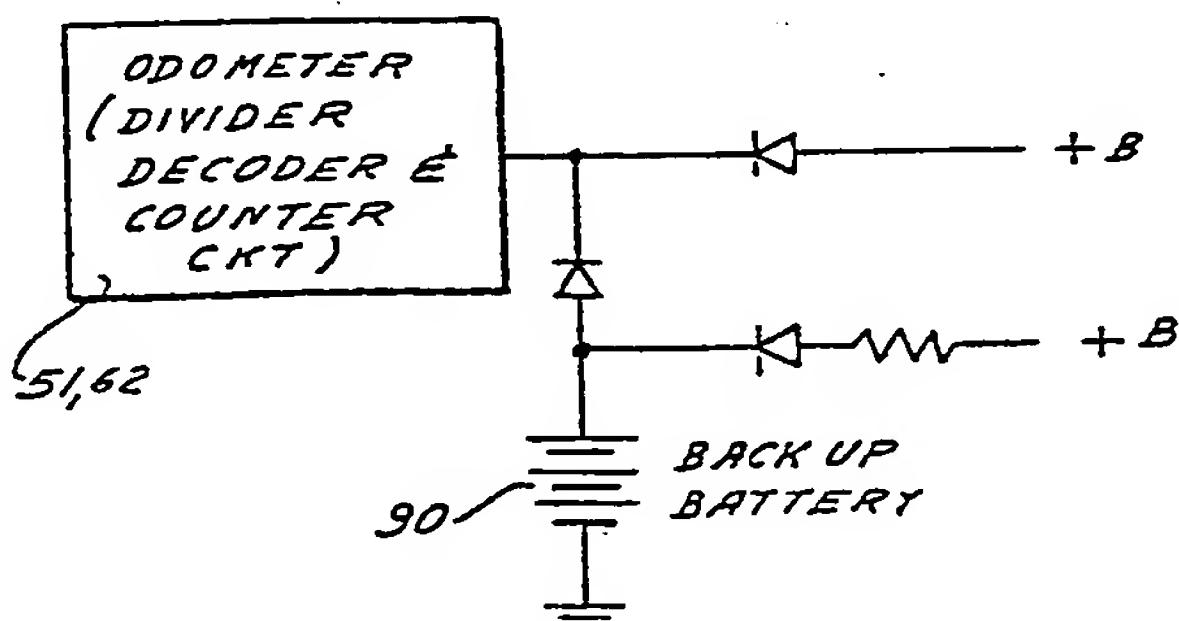
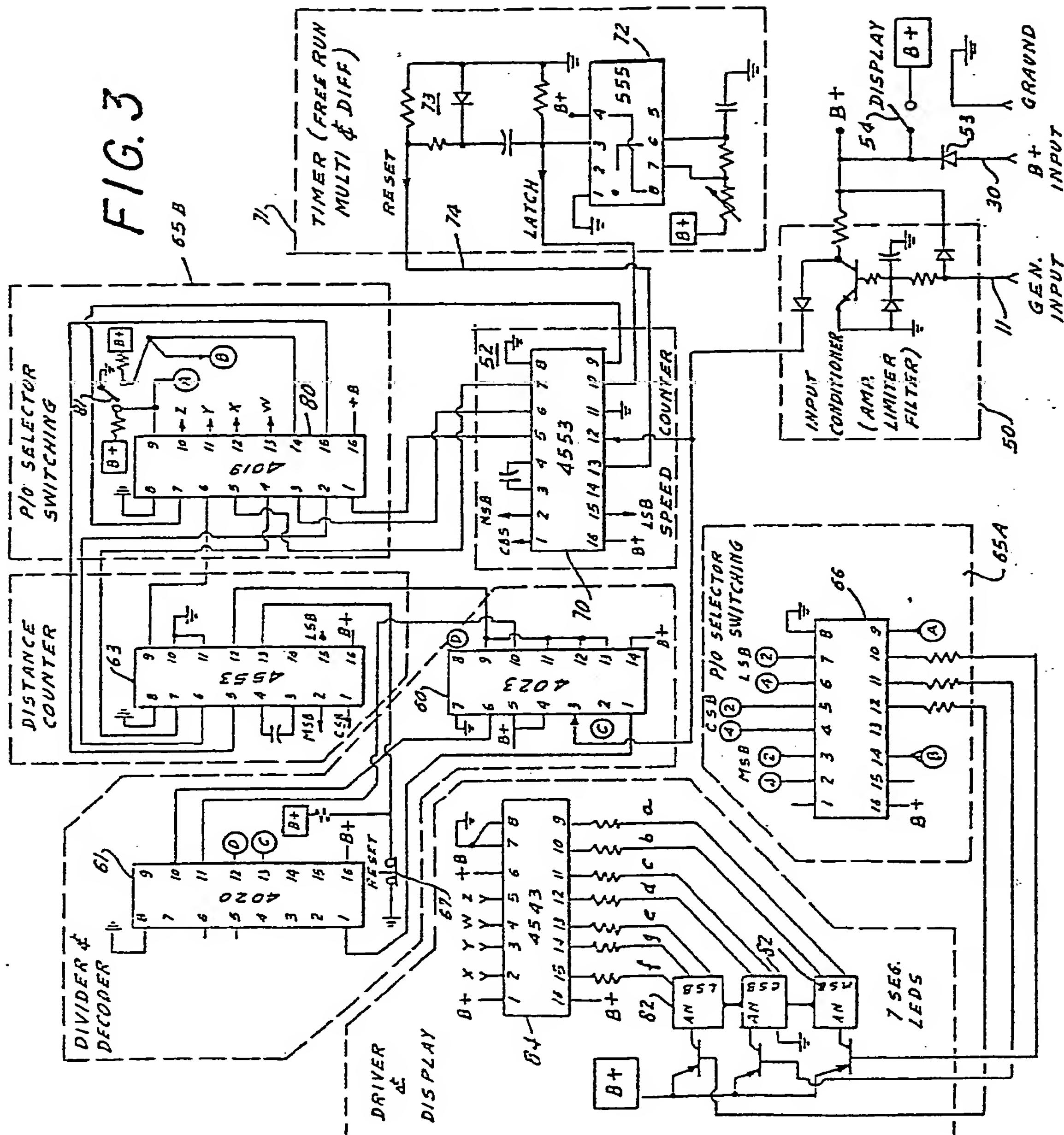


FIG. 4



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FIG. 3



INTERNATIONAL SEARCH REPORT

International Application No PCT/US80/01123

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³

According to International Patent Classification (IPC) or to both National Classification and IPC
 INT. CL. ³ B62 J 5/00; G01P 3/489
 U.S. CL. 315/78; 324/166

II. FIELDS SEARCHED

Minimum Documentation Searched ⁴

Classification System	Classification Symbols	
	315/78-79, 175	73/2, 488
U.S.	324/166, 168, 171	235/95B
	307/9	

Documentation Searched other than Minimum Documentation
 to the Extent that such Documents are Included in the Fields Searched ⁵

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US, A, 3,904,920, Published 09 SEPTEMBER 1975, GRIFFITH	6-16
X	US, A, 4,007,419, Published 08 FEBRUARY 1977, JASMINE	1-5, 12, 17
A	US, A, 4,000,465, Published 28 DECEMBER 1976, SUGIYAMA	1-5, 12, 17
A	US, A, 4,156,190, Published 22 MAY 1979, CHITTENDEN ET AL	1-5, 12, 17

* Special categories of cited documents: ¹⁵

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search ²

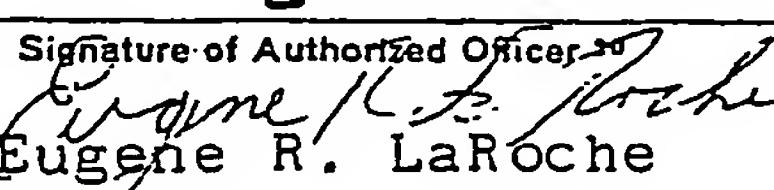
10 DECEMBER 1980

Date of Mailing of this International Search Report ³

23 JAN 1981

International Searching Authority ¹

ISA/US

Signature of Authorized Officer ²⁰

 Eugene R. LaRoche

